Apprenticeship and Industry Training

Tool and Die Maker

Apprenticeship Course Outline

9607 (2007)

Alberta

Apprenticeship and Industry Training

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Tool and Die Maker
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Course Outline

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Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding an employer. Employers hire apprentices, pay their wages and provide on-the-job training and work experience. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyperson or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution – usually a college or technical institute.

To become certified journeypersons, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board on the recommendation of Tool and Die Maker Provincial Apprenticeship Committee.

The graduate of the Tool and Die Maker apprenticeship program is a certified journeyperson who will be able to:

- have a thorough knowledge and understanding of the hand tools and power operated machines used for the shaping of metal into usable parts
- be skilful in the safe use of these tools in order to produce machine parts according to specifications
- be capable of reading and laying out projects from drawings
- skilfully use measuring devices to reproduce machine parts according to specifications
- know the characteristics of various metals
- understand the effects of heat treatment on metals and be skilful in the performance of the various heat treatment processes
- be familiar with the work in related trades such as mechanics, millwrights, machinists and welders
- produce work economically and meet the requirements of a competitive industry
- perform assigned tasks in accordance with quality and production standards required by industry

Apprenticeship and Industry Training System

Industry-Driven

Alberta's apprenticeship and industry training system is an industry-driven system that ensures a highly skilled, internationally competitive workforce in more than 50 designated trades and occupations. This workforce supports the economic progress of Alberta and its competitive role in the global market. Industry (employers and employees) establishes training and certification standards and provides direction to the system through an industry committee network and the Alberta Apprenticeship and Industry Training Board. The Alberta government provides the legislative framework and administrative support for the apprenticeship and industry training system.

Alberta Apprenticeship and Industry Training Board

The Alberta Apprenticeship and Industry Training Board provides a leadership role in developing Alberta's highly skilled and trained workforce. The board's primary responsibility is to establish the standards and requirements for training and certification in programs under the Apprenticeship and Industry Training Act. The board also provides advice to the Minister of Advanced Education and Technology on the needs of Alberta's labour market for skilled and trained workers, and the designation of trades and occupations.

The thirteen-member board consists of a chair, eight members representing trades and four members representing other industries. There are equal numbers of employer and employee representatives.

Industry Committee Network

Alberta's apprenticeship and industry training system relies on a network of industry committees, including local and provincial apprenticeship committees in the designated trades, and occupational committees in the designated occupations. The network also includes other committees such as provisional committees that are established before the designation of a new trade or occupation comes into effect. All trade committees are composed of equal numbers of employer and employee representatives. The industry committee network is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the board can set up a local apprenticeship committee. The board appoints equal numbers of employee and employer representatives for terms of up to three years. The committee appoints a member as presiding officer. Local apprenticeship committees:

- monitor apprenticeship programs and the progress of apprentices in their trade, at the local level
- make recommendations to their trade's provincial apprenticeship committee (PAC) about apprenticeship and certification in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- make recommendations to the board about the appointment of members to their trade's PAC
- help settle certain kinds of disagreements between apprentices and their employers
- carry out functions assigned by their trade's PAC or the board

Provincial Apprenticeship Committees (PAC)

The board establishes a provincial apprenticeship committee for each trade. It appoints an equal number of employer and employee representatives, and, on the PAC's recommendation, a presiding officer - each for a maximum of two terms of up to three years. Most PACs have nine members but can have as many as twenty-one. Provincial apprenticeship committees:

- Make recommendations to the board about:
  - standards and requirements for training and certification in their trade
  - courses and examinations in their trade
  - apprenticeship and certification
  - designation of trades and occupations
  - regulations and orders under the Apprenticeship and Industry Training Act
- monitor the activities of local apprenticeship committees in their trade
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- consult with other committees under the Apprenticeship and Industry Training Act about apprenticeship programs, training and certification and facilitate cooperation between different trades and occupations
- consult with organizations, associations and people who have an interest in their trade and with employers and employees in their trade
- may participate in resolving certain disagreements between employers and employees
- carry out functions assigned by the board

Tool and Die Maker PAC Members at the time of publication.

Mr. P. Hermann	Calgary	Presiding Officer
Mr. C. Imer	Calgary	Employer
Mr. E. Wisniewski	Edmonton	Employer
Mr. D. Atfield	Calgary	Employee
Mr. C. Stern	Calgary	Employee
Mr. A. Vozila	Calgary	Employee
Mr. H. Huelmbauer	Edmonton	Employee

Alberta Government

Alberta Advanced Education and Technology works with industry, employer and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and employers
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

Technical Institutes and Colleges

The technical institutes and colleges are key participants in Alberta's apprenticeship and industry training system. They work with the board, industry committees and Alberta Advanced Education and Technology to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs. They develop lesson plans from the course outlines established by industry and provide technical training to apprentices.

Apprenticeship Safety

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

Alberta Apprenticeship and Industry Training Board Safety Policy

The Alberta Apprenticeship and Industry Training Board fully supports safe learning and working environments and encourages the teaching of proper safety procedures both within trade specific training and in the workplace.

Trade specific safety training is an integral component of technical training, while ongoing or general non-trade specific safety training remains the responsibility of the employer and the employee as required under workplace health and safety legislation.

Workplace Responsibilities

The employer is responsible for:

- training employees and apprentices in the safe use and operation of equipment
- providing and maintaining safety equipment, protective devices and clothing
- enforcing safe working procedures
- providing safeguards for machinery, equipment and tools
- observing all accident prevention regulations

The employee and apprentice are responsible for:

- working in accordance with the safety regulations pertaining to the job environment
- working in such a way as not to endanger themselves, fellow employees or apprentices

Workplace Health and Safety

A tradesperson is often exposed to more hazards than any other person in the work force and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Workplace Health and Safety (Alberta Employment, Immigration and Industry) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.worksafely.org

Technical Training

Apprenticeship technical training is delivered by the technical institutes and many colleges in the public post-secondary system throughout Alberta. The colleges and institutes are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All training providers place great emphasis on safe technical practices that complement safe workplace practices and help to develop a skilled, safe workforce.

The following institutions deliver Tool and Die Maker apprenticeship technical training:

Northern Alberta Institute of Technology
Southern Alberta Institute of Technology
Red River College, Manitoba

Procedures for Recommending Revisions to the Course Outline

Advanced Education and Technology has prepared this course outline in partnership with the Tool and Die Maker Provincial Apprenticeship Committee.

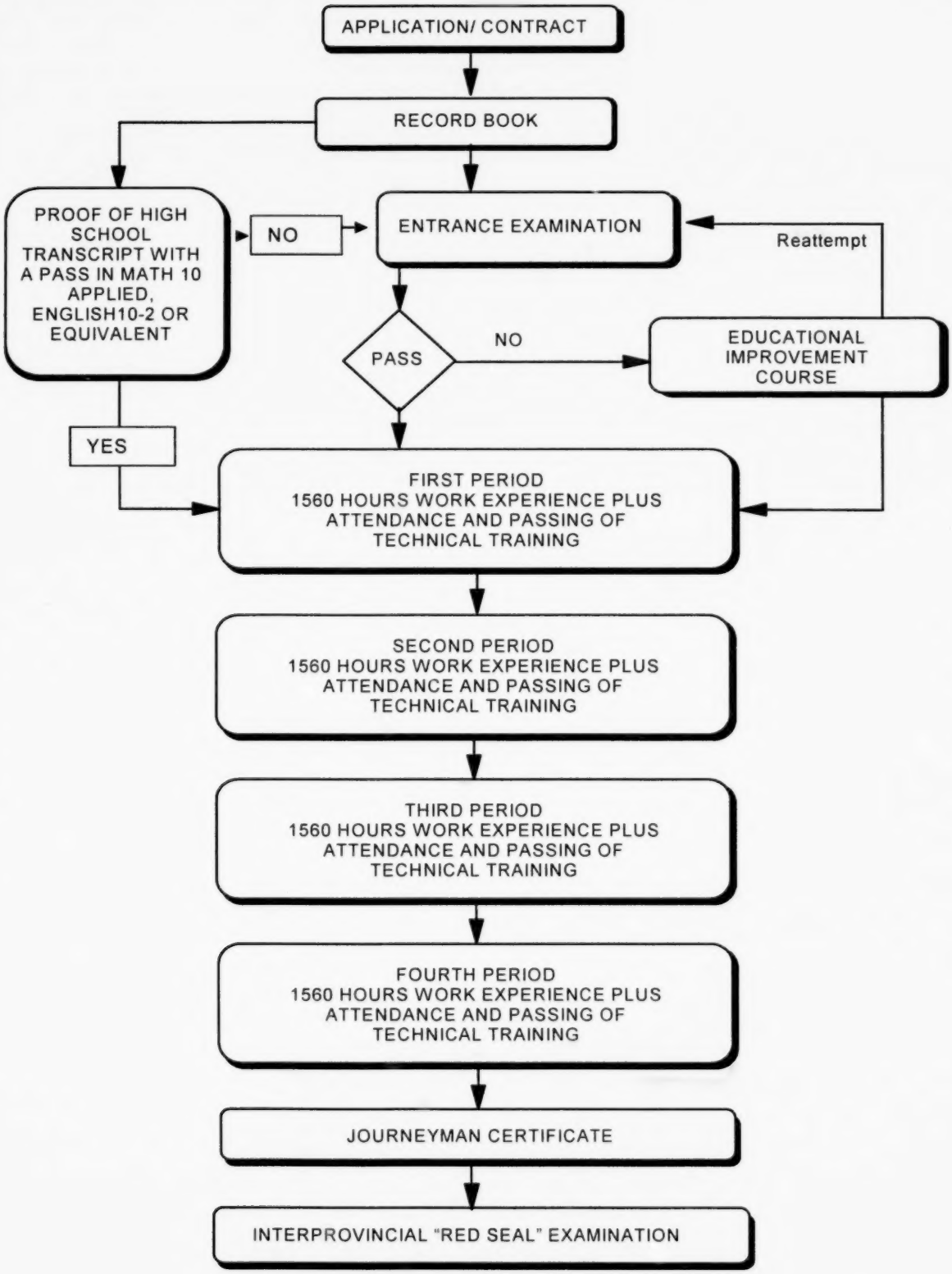
This course outline was approved on February 2, 2007 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

Tool and Die Maker Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
Advanced Education and Technology
10th floor, Commerce Place
10155 102 Street NW
Edmonton AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations for change will be placed on the agenda for regular meetings of the Tool and Die Maker Provincial Apprenticeship Committee.

Apprenticeship Route toward Certification


APPLICATION/ CONTRACT
RECORD BOOK
PROOF OF HIGH SCHOOL TRANSCRIPT WITH A PASS IN MATH 10 APPLIED, ENGLISH10-2 OR EQUIVALENT
NO
ENTRANCE EXAMINATION
Reattempt
PASS
NO
EDUCATIONAL IMPROVEMENT COURSE
YES
FIRST PERIOD
1560 HOURS WORK EXPERIENCE PLUS ATTENDANCE AND PASSING OF TECHNICAL TRAINING
SECOND PERIOD
1560 HOURS WORK EXPERIENCE PLUS ATTENDANCE AND PASSING OF TECHNICAL TRAINING
THIRD PERIOD
1560 HOURS WORK EXPERIENCE PLUS ATTENDANCE AND PASSING OF TECHNICAL TRAINING
FOURTH PERIOD
1560 HOURS WORK EXPERIENCE PLUS ATTENDANCE AND PASSING OF TECHNICAL TRAINING
JOURNEYMAN CERTIFICATE
INTERPROVINCIAL "RED SEAL" EXAMINATION

Tool and Die Maker Training Profile
FIRST PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

THEORY — **72 HOURS**

A	B	C
WHMIS 150101a — 2 Hours	Basic Measuring Tools 150101b — 2 Hours	Precision Measuring Tools 150101c — 2 Hours
D	**E**	**F**
Angular Measuring Tools 150101d — 2 Hours	Inspection Gauges 150101e — 2 Hours	Layout Tools and Procedures 150101f — 2 Hours
G	**H**	**I**
Non-Cutting Hand Tools 151010g — 4 Hours	Hand-Held Cutting Tools 150101h — 6 Hours	Screw Thread Terminology 150101i — 5 Hours
J	**K**	**L**
Screw Thread Measuring and Gauging 150101j — 3 Hours	Fasteners and Locking Devices 150101k — 3 Hours	Tapers Systems 150101l — 5 Hours
M	**N**	**O**
Machine Lubrication and Cutting Fluids 150101m — 2 Hours	Hand Grinding Machines 150101n — 2 Hours	Drilling Machines 150101o — 8 Hours
P	**Q**	**R**
Types of Lathes 150101p — 6 Hours	Speeds, Feeds and Cutting Tools 150101q — 4 Hours	Lathe Operations 150101r — 8 Hours
S	**T**	
Power Saws and Cut-Off Machines 150101s — 2 Hours	Machine Shop Rigging 150101t — 2 Hours	

SECTION TWO

METALLURGY AND HEAT TREATMENT — **8 HOURS**

A	B
Metallurgy 150102a — 4 Hours	Oxyacetylene Equipment 150102b — 4 Hours

SECTION THREE

TRADE MATHEMATICS — **24 HOURS**

A	B	C
Manipulation of Whole Numbers, Fractions, and Decimals. 3 Hours	Measurements and Conversions 2 Hours	Formulas and Equations 6 Hours
D	**E**	**F**
Reading Tables, Graphs and Nomographs 2 Hours	Ratio and Proportion 3 Hours	Percentage Calculations 3 Hours
G		
Triangles 5 Hours		

SECTION FOUR

PRINT READING

24 HOURS

A

Introduction to Print Reading

150104a 9 Hours

B

Dimensioning Methods

150104b 3 Hours

C

Isometric Drawings

150104c 4 Hours

D

Sections

150104d 4 Hours

E

Applied Print Reading

150104e 4 Hours

SECTION FIVE

SHOPWORK

112 HOURS

A

Measurement

8 Hours

B

Layout

8 Hours

C

Hand Tools and Benchwork

12 Hours

D

Threads

6 Hours

E

Lubrication

1 Hour

F

Hand Grinding

9 Hours

G

Drill Presses

5 Hours

H

Engine Lathes

58 Hours

I

Power Saws and Cut-Off Machines

1 Hour

J

Metallurgy

1 Hour

K

Heat Treatment

1 Hour

L

Oxyacetylene

1 Hour

M

Rigging

1 Hour

SECOND PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

THEORY — **48 HOURS**

A	B	C
Milling Machines 150201a — 4 Hours	Milling Cutters 150201b — 5 Hours	Tool and Work Holding Devices 150201c — 2 Hours
D	**E**	**F**
Milling Operations 150201d — 9 Hours	Dividing Head and Indexing 150201e — 4 Hours	Advanced Threading 150201f — 8 Hours
G	**H**	**I**
Lathe Attachments and Accessories 150201g — 4 Hours	Advanced Cutting Tool Materials 150201h — 4 Hours	Inserts and Tool Holders 150201i — 4 Hours
J	**K**	
Using Carbide Inserts 150201j — 2 Hours	Shapers and Slotters 150201k — 2 Hours	

SECTION TWO

COMPUTER NUMERICAL CONTROM MACHINES — **12 HOURS**

A	B	C
CNC Machines: Introduction and Applications 150202a — 2 Hours	CNC Turning Centers: Types, Parts and Workholding Accessories 150202b — 2 Hours	CNC Turning Centers: Program and Machine Coordination Systems 150202c — 2 Hours
D	**E**	**F**
CNC Turning Centers: Cutting Conditions and Operations 150202d — 2 Hours	CNC Turning Centers: Program Concepts and Codes 150202e — 2 Hours	CNC Turning Centers: Program Applications 150202f — 2 Hours

SECTION THREE

METALLURGY — **16 HOURS**

A	B
Base Metals and Alloys 150203a — 10 Hours	Metal Specification and Testing 150203b — 6 Hours

SECTION FOUR

TRADE MATHEMATICS — **24 HOURS**

A	B	C
Measurements, Conversions, Ratio and Proportion 6 Hours	Applied Mathematics 14 Hours	Applied Geometry 4 Hours

SECTION FIVE

PRINT READING — **24 HOURS**

A	B	C
Interpret and Sketch Blueprints 150205a — 8 Hours	Symbols and Abbreviations 150205b — 8 Hours	Assembly and Sub-Assembly Drawings 150205c — 8 Hours

SECTION SIX

MACHINERY'S HANDBOOK — **8 HOURS**

A
Machinery's Handbook 150206a — 8 Hours

SECTION SEVEN

SHOPWORK — **112 HOURS**

A	B	C
Milling Machines 54 Hours	Engine Lathes 46 Hours	Lathe Attachments 6 Hours
D		
CNC Machining 6 Hours		

THIRD PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

ABRASIVE PRODUCTS
6 HOURS

A
Abrasive Products
6 Hours

SECTION TWO

GRINDING MACHINES AND PROCESSES
20 HOURS

A
Grinding Machines And Processes
20 Hours

SECTION THREE

GEARING
11 HOURS

A
Gearing
11 Hours

SECTION FOUR

BORING MILLS
4 HOURS

A
Boring Mills
4 Hours

SECTION FIVE

JIG BORING, GRINDING AND MACHINE BROACHING
3 HOURS

A
Jig Boring
2 Hours

B
Machine Broaching
1 Hour

SECTION SIX

JIG AND FIXTURES
75 HOURS

A
Jigs
45 Hours

B
Fixtures
30 Hours

SECTION SEVEN

SHOP ESTIMATING
4 HOURS

A
Introduction to Shop Estimating
4 Hours

SECTION EIGHT

WELDING
10 HOURS

A
TIG and Micro Welding
10 Hours

SECTION NINE

COMPUTER NUMERICAL CONTROL MACHINES
55 HOURS

A
Machine Types, Parts and Functions
150402a 4 Hours

B
Manufacturing Systems
150402b 3 Hours

C
Machine and Workpiece Co-ordinate Systems
150402c 5 Hours

D
Programming Concepts, Codes and Structure
150402d 8 Hours

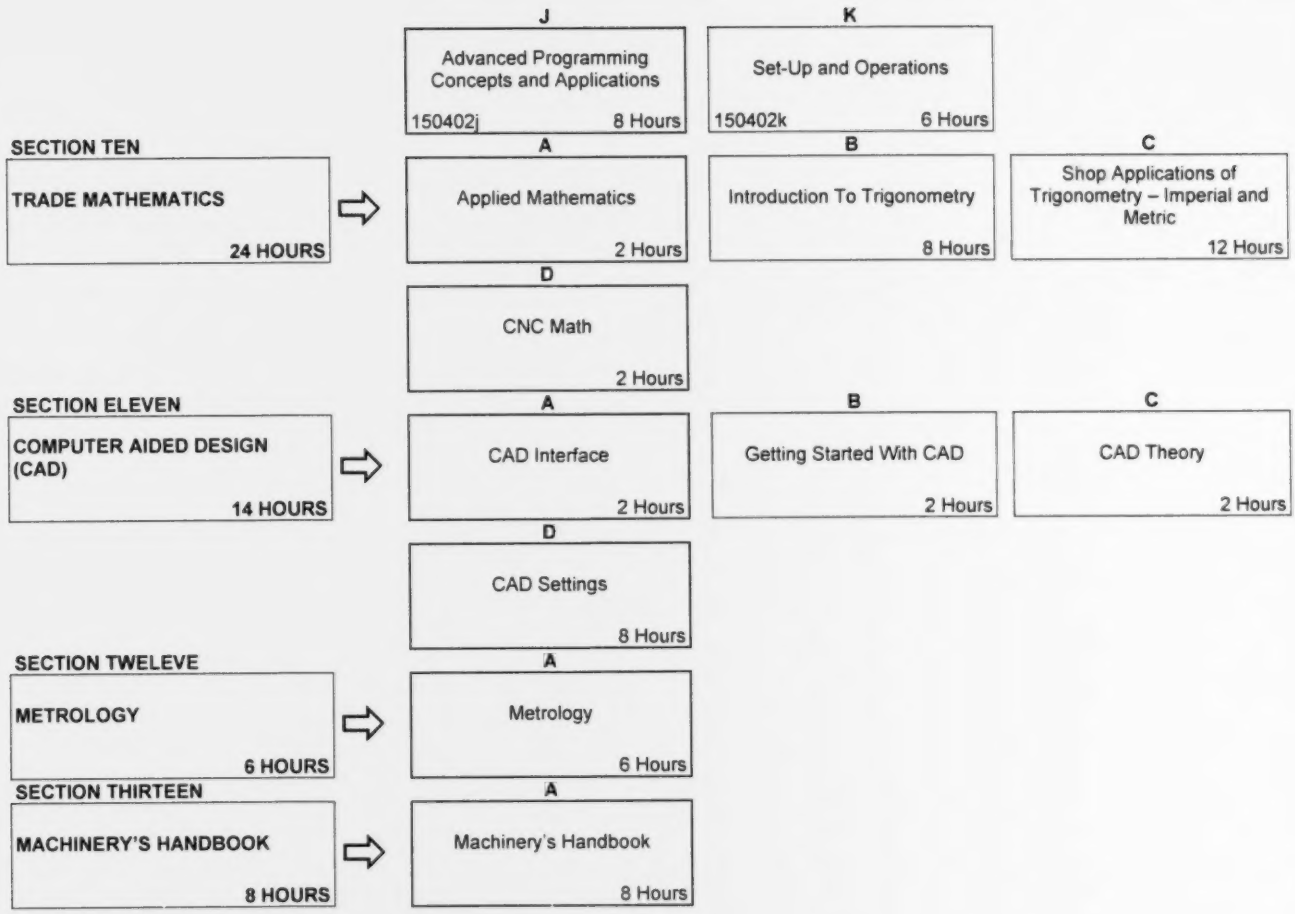
E
Machining Conditions
150402e 4 Hours

F
Canned Cycles: Theory
150402f 3 Hours

G
Canned Cycles: Program Applications
150402g 6 Hours

H
Linear and Circular Interpolation
150402h 4 Hours

I
Cutter Radius Compensation
150402i 4 Hours


J
Advanced Programming Concepts and Applications
150402j 8 Hours
K
Set-Up and Operations
150402k 6 Hours
SECTION TEN
TRADE MATHEMATICS
24 HOURS
A
Applied Mathematics
2 Hours
B
Introduction To Trigonometry
8 Hours
C
Shop Applications of Trigonometry – Imperial and Metric
12 Hours
D
CNC Math
2 Hours
SECTION ELEVEN
COMPUTER AIDED DESIGN (CAD)
14 HOURS
A
CAD Interface
2 Hours
B
Getting Started With CAD
2 Hours
C
CAD Theory
2 Hours
D
CAD Settings
8 Hours
SECTION TWELEVE
METROLOGY
6 HOURS
A
Metrology
6 Hours
SECTION THIRTEEN
MACHINERY'S HANDBOOK
8 HOURS
A
Machinery's Handbook
8 Hours

FOURTH PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

		A	B	C
SECTION ONE	**METROLOGY** 8 HOURS	Metrology 8 Hours		
SECTION TWO	**MILLING TECHNOLOGY** 10 HOURS	Milling Technology 10 Hours		
SECTION THREE	**GRINDING TECHNOLOGY** 15 HOURS	Grinding Technology 15 Hours		
SECTION FOUR	**ELECTRICAL DISCHARGE MACHINING** 12 HOURS	Electrical Discharge Machining And Sinker Process 12 Hours		
SECTION FIVE	**CNC TECHNOLOGY** 28 HOURS	CNC Technology for Tool and Die Making 28 Hours		
SECTION SIX	**STAMPING, FORGING MOULDING TECHNOLOGY** 25 HOURS	Stamping Technology 10 Hours	Forging 5 Hours	Mould Making 10 Hours
SECTION SEVEN	**MECHANICAL ASSEMBLY TECHNOLOGY** 10 HOURS	Mechanical Assembly Technology For Tool and Die Making 10 Hours		
SECTION EIGHT	**DIE AND MOULD BUILDING** 100 HOURS	Planning Process 25 Hours	Machinery Process 25 Hours	Assembly and Processes 25 Hours
		D		
		Production and Processes 25 Hours		
SECTION NINE	**APPLIED TRADE CALCULATIONS** 32 HOURS	Advanced Math And Unknown Values 32 Hours		

NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training.

FIRST PERIOD TECHNICAL TRAINING
TOOL AND DIE MAKER TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... THEORY ..... 72 HOURS

A. WHMIS (150101a) ..... 2 Hours

Outcome: ***Apply the requirements of WHMIS to the worksite.***

1. Describe the three key elements of WHMIS.
2. Identify WHMIS safety hazard symbols.
3. Interpret the Material Safety Data Sheet (MSDS).

B. Basic Measurement Tools (150101b) ..... 2 Hours

Outcome: ***Measure components using basic tools common to the trade.***

1. Identify basic measuring tools common to the trade.
2. Measure round and flat components to 1/64" or 0.5 mm accuracy.

C. Precision Measuring Tools (150101c) ..... 2 Hours

Outcome: ***Measure workpieces using precision measuring tools common to the trade.***

1. Identify precision measuring tools used in the machine shop.
2. Perform precision measurement with both metric and imperial measuring tools.
3. Demonstrate correct care and use of measuring tools.

D. Angular Measuring Tools (150101d) ..... 2 Hours

Outcome: ***Measure workpieces using angular measuring tools common to the trade.***

1. Measure angles using a bevel and plate protractor.
2. Measure to within 5 minutes of a degree of accuracy using a universal bevel protractor.
3. Describe dial indicators and gauge blocks for measurement and set-up operations.
4. Perform angular measurement using the sine bar method.
5. Identify three types of sine plate.
6. Identify, select and apply precision squares for checking squareness of workpeices and set-up purposes.

E. Inspection Gauges (150101e) ..... 2 Hours

Outcome: ***Check components using various types of inspection gauges.***

1. Use fixed gauges to check the accuracy of components.
2. Define the terminology associated with limits and fits.
3. Explain the effects of temperature changes, with respect to measuring components, when applying limits and fits.

F. Layout Tools and Procedures (150101f)..... 2 Hours

Outcome: ***Perform semi-precision and precision layout procedures.***

1. Identify the tools for layout procedures.
2. Explain the procedures for basic (semi-precision) and precision layout.

G. Non-Cutting Hand Tools (150101g)..... 4 Hours

Outcome: ***Demonstrate the correct use of non-cutting hand tools common to the trade.***

1. Select the appropriate hand tool to hold, assemble or disassemble components.
2. Describe the proper technique to hold, assemble or disassemble components.
3. Describe the use of metal stamps for marking components.

H. Hand-held Cutting Tools (150101h)..... 6 Hours

Outcome: ***Demonstrate the correct use of hand-held cutting tools common to the trade.***

1. Describe hacksaws, hacksaw blades, and hole saws.
2. Describe the parts, types, classification, shape and use of files.
3. Describe the use of scrappers and chisels.
4. Describe the use of taps and dies, stud and bolt removal tools, and the proper lubricant for these applications.
5. Describe hand reamers and their applications.
6. Describe the use of hand-held cutting pliers, hand broaching tools and abrasives.

I. Screw Thread Terminology (150101i)..... 5 Hours

Outcome: ***Interpret a thread designation.***

1. Define the term screw thread and list four screw thread applications.
2. Identify the parts of external and internal screw threads.
3. Identify eight screw thread forms and their applications.
4. Explain the terminology associated with thread classification and fits.

J. Screw Thread Measuring and Gauging (150101j)..... 3 Hours

Outcome: ***Inspect screw thread forms using five gauging and measuring methods.***

1. Perform thread calculations for four thread forms.
2. Describe the various methods used to accurately measure and gauge threads.

K. Fasteners and Locking Devices (150101k)..... 3 Hours

Outcome: ***Select a threaded or non-threaded mechanical fastener to meet job specifications.***

1. Identify types of threaded fasteners and their applications.
2. Identify types of non-threaded fasteners and their applications.

L. Taper Systems (150101l) ..... 5 Hours

Outcome: ***Apply taper systems to machining operations.***

1. State four applications of tapers.
2. Identify the individual parts of a taper.
3. Describe the various methods used to measure or gauge an external or internal taper for fit and accuracy.
4. Identify eight taper systems and their applications.
5. Perform calculations for both metric and imperial tapers.

M. Machine Lubrication and Cutting Fluids (150101m) ..... 2 Hours

Outcome: ***Apply lubricants to reduce friction and increase efficiency.***

1. Describe the purpose of lubrication.
2. Interpret lubrication schedules from manufacturer's specifications and apply the appropriate lubricant.
3. Identify the various methods used to apply lubricants.
4. Describe the characteristics and functions of a cutting fluid.
5. Describe the applications and potential health hazards of cutting fluids.

N. Hand Grinding Machines (150101n) ..... 2 Hours

Outcome: ***Perform off-hand grinding on the bench or pedestal grinder.***

1. Identify three types of hand grinding machines and the types of wheels they use.
2. Describe the correct method to install, true and dress a grinding wheel.

O. Drilling Machines (150101o) ..... 8 Hours

Outcome: ***Describe the procedures to operate drilling machines.***

1. Identify seven types of drilling machines, their main parts and attachments.
2. Describe the various types of drill press operations.
3. Describe tool and work holding devices.
4. Identify the parts of a twist drill and the types of twist drill materials.
5. Describe special types of drills and reamers.
6. Explain metric, fractional, letter and number drill sizes and methods of measuring drill sizes.
7. Describe the different procedures for grinding a drill bit and the techniques used to correct for drilling problems.
8. Calculate the correct speeds and feeds for drill press operations.

P. Types of Lathes (150101p) ..... 6 Hours

Outcome: ***Describing the sizing, parts, accessories and attachments of lathe types.***

1. Identify the types, size, and related capacity of lathes found in industry.
2. Describe the five major parts of an engine lathe and their functions.
3. Explain the use of work holding devices when used on the lathe.
4. Describe lathe accessories and their applications.
5. Explain the use of tool posts and cutting tool holders.
6. Prevent potential hazards by following the safety procedures when operating lathe.

Q. Speeds, Feeds and Cutting Tools (150101q) ..... 4 Hours

Outcome: ***Determine the feed, speed, and depth of cut for turning operations.***

1. Describe the composition and characteristics of six types of cutting tool materials.
2. Identify the shapes, angles and clearances, when grinding a cutting tool.
3. Calculate the speeds and feeds for various cutting tool and workpiece materials.
4. Determine the depth of cut and feed rate based on five determining factors.

R. Lathe Operations (150101r) ..... 8 Hours

Outcome: ***Perform engine lathe set-ups and operations safely.***

1. Set-up the cutting tool to perform parallel turning and boring operations.
2. Operate a lathe to turn a shoulder.
3. Perform center drilling, drilling and reaming operations.
4. Set-up a lathe to cut tapers.
5. Perform knurling, grooving, parting-off, forming and profiling, in the lathe.
6. Use taps, dies, and a single point tool to cut a thread.
7. Describe the use of steady rests, follower rests, and mandrels on the lathe.
8. Follow safety guidelines when performing finishing operations in the lathe.

S. Power Saws and Cut-off Machines (150101s) ..... 2 Hours

Outcome: ***Operate power saws and cut-off machines safely.***

1. Describe the types, design features, and applications of power saws and cut-off machines.
2. Demonstrate the correct procedures when using power saws and cut-off machines.
3. Select a saw blade or cut-off wheel.

T. Machine Shop Rigging (150101t) ..... 2 Hours

Outcome: ***Comply with Occupational Health and Safety Regulations when hoisting machine components in the machine shop.***

1. Describe rigging hardware and the safety factor associated with each item.
2. Demonstrate hoisting procedures and methods of calculating sling tension and load weight.

SECTION TWO: ..... METALLURGY AND HEAT TREATMENT ..... 8 HOURS

A. Metallurgy (150102a) ..... 4 Hours

Outcome: ***Select the correct type of metal for an application.***

1. Explain five physical and mechanical properties of steel and the factors that change these properties.
2. Describe steel processing and finishing methods and the shapes that may be produced by rolling.
3. Demonstrate the use of the SAE-AISI classification system to identify metals.
4. Describe heat-treating and the terminology associated with these processes.

B. Oxyacetylene Equipment (150102b) ..... 4 Hours

Outcome: ***Use oxyacetylene equipment for heating, cutting and silver brazing.***

1. Use the appropriate safety precautions and devices.
2. Describe oxygen and acetylene cylinders and the nature and production of the gases.
3. Install oxyacetylene equipment safely.
4. Describe set-up, pressure and flame adjustment, and shutdown, when using oxyacetylene equipment.
5. Perform heating, cutting and silver brazing operations.

SECTION THREE: ..... TRADE MATHEMATICS ..... 24 HOURS

A. Manipulation of Whole Numbers, Fractions and Decimals ..... 3 Hours

Outcome: ***Manipulate whole numbers, fractions and decimals.***

1. Solve problems involving addition and subtraction of whole numbers and decimals.
2. Solve problems involving multiplication and division of whole numbers and decimals.
3. Calculate the average of several numbers.
4. Factor fractions to lowest common denominator.
5. Calculate the lowest common multiple.
6. Add and subtract fractions.
7. Multiply and divide fractions.
8. Solve exponential problems involving whole numbers and fractions.
9. Convert fractions to decimals and vice versa.
10. Round off whole numbers, fractions and decimals.

B. Measurements and Conversions .....2 Hours

Outcome: ***Calculate measurements and conversions using metric and imperial measurement systems.***

1. List the basic metric units of length, mass, volume, time and temperature with their symbols.
2. Define the prefixes used to indicate large and small quantities.
3. List the derived metric units and their symbols.
4. Convert imperial units to metric and vice versa using tables and calculators.
5. List the conversions and equivalents for Imperial measurement.

C. Formulas and Equations .....6 Hours

Outcome: ***Manipulate formulas and equations.***

1. Recognize and be able to manipulate formulas according to the proper math rules.
2. Group formulas and equations according to their sequence of operations and be able to solve problems using these rules.
3. Solve various problems with the use of proper formula in both imperial and metric for area, volumes, perimeter and circumference.

D. Reading Tables, Graphs and Nomographs .....2 Hours

Outcome: ***Read tables, graphs and nomographs.***

1. Read and interpret tables and graphs available to provide information to the machinist.
2. Solve problems using tables and graphs used in the machinist trade.

E. Ratio and Proportion .....3 Hours

Outcome: ***Define and use ratio and proportion.***

1. Define ratio.
2. Define proportion.
3. Apply ratio and proportion formula in solving various shop problems involving gearing and pulleys.

F. Percentage Calculations .....3 Hours

Outcome: ***Solve problems using percentages.***

1. Calculate percent for various mathematical expressions used in the machinist trade.
2. Change percentages of various mathematical expressions used in the machinist trade.

G. Triangles .....5 Hours

Outcome: ***Identify and use triangles.***

1. Identify common triangles.
2. Identify parts of triangles.
3. Define and apply the Pythagorean theorem.
4. Define and apply the similar triangle method to determine the angles on a right angle triangle.
5. Identify and explain the application of triangles.
6. Demonstrate the use of ratio and proportion using triangles to solve shop problems.

SECTION FOUR: .....PRINT READING.....24 HOURS

A. Introduction to Print Reading (150104a).....9 Hours

Outcome: ***Read and sketch basic components.***

1. Identify the six planes of an orthographic projection and the "key view".
2. Identify first and third angle projections, and recognize the ISO symbol for each projection.
3. Describe the types of lines used on prints and their applications.
4. Describe basic sketching equipment.
5. Use basic rules to apply dimensions to a component drawing.
6. Sketch and dimension simple objects in orthographic projection.

B. Dimensioning Methods (150104b).....3 Hours

Outcome: ***Dimension and interpret various common elements.***

1. Describe the different methods of applying special dimensions to a technical element on a print.
2. State the methods used to express the amount of taper on a component drawing.
3. Read dimensions on prints in both metric and imperial systems or dual dimensioning.

C. Isometric Drawings (150104c) .....4 Hours

Outcome: ***Sketch pictorial drawings.***

1. Calculate for missing dimensions on a drawing.
2. Describe three types of picture views.
3. Sketch isometric drawings on isometric lined paper.

D. Sections (150104d) .....4 Hours

Outcome: ***Recognize and name technical elements of break lines and sectional representation.***

1. Define the terms cutting plane lines, break lines and symmetry and describe their application.
2. Describe the use of sectional views and name the types of components that would not be sectioned on a drawing.
3. Draw symbolic section lines for seven types of material.

E. Applied Print Reading (150104e) ..... 4 Hours

Outcome: ***Sketch and interpret machine shop drawings containing applied print reading terminology.***

1. Calculate the limits and fits for the mating parts on working drawings.
2. Apply all dimensions and tolerances to a set of working drawings.
3. Interpret prints including all information generally provided on prints, shop drawings and sketches.

SECTION FIVE: ..... SHOPWORK ..... 112 HOURS

Shop work experience will relate items outlined in the theory section to shop operations by producing selected shop projects. This experience should compliment the theory instruction by providing opportunities for efficient, productive and safe operation and/or demonstrations thereof.

A. Measurement ..... 8 Hours

Outcome: ***Use various measurement devices.***

1. Demonstrate ability to measure and fit with the use of various measurement devices.

B. Layout ..... 8 Hours

Outcome: ***Perform layout using appropriate tools.***

1. Perform layout procedures using various layout tools.

C. Hand Tools and Benchwork ..... 12 Hours

Outcome: ***Develop ability to use hand tools.***

1. Demonstrate an ability to perform operations with the use of various hand tools.

D. Threads ..... 6 Hours

Outcome: ***Demonstrate thread cutting and related operations.***

1. Perform various thread cutting and related operations using the proper tools.
2. Perform various thread repair operations.

E. Lubrication ..... 1 Hour

Outcome: ***Perform lubrications on various machine tools.***

1. Perform proper lubrication requirements on various machine tools using the required lubricants.
2. Use manufacturer's lubrication charts for proper lubrication.

F. Hand Grinding ..... 9 Hours

Outcome: ***Demonstrate the use and maintenance of offhand and bench grinders.***

1. Demonstrate an ability to use offhand and bench grinders for grinding and sharpening.
2. Demonstrate and perform maintenance operations on grinders.

G. Drill Presses ..... **5 Hours**

Outcome: ***Perform various drilling operations.***

1. Perform drilling operations using various drilling machines and attachments.
2. Demonstrate an ability to safely and efficiently perform various functions on the appropriate drilling machines.

H. Engine Lathes ..... **58 Hours**

Outcome: ***Demonstrate various lathe operations and set-ups.***

1. Safely and efficiently perform various set ups for different operations on the engine lathe.
2. Demonstrate an ability to perform various operations on the lathe.

I. Power Saws and Cut-Off Machines ..... **1 Hour**

Outcome: ***Demonstrate various operations using power saws and cut-off machines.***

1. Perform stock cutting operations on power saws.
2. Perform sawing operations on the contour bandsaw.
3. Demonstrate various functions related to bandsaws.
4. Perform stock cutting operations on the abrasive cut-off machine.

J. Metallurgy ..... **1 Hour**

Outcome: ***Demonstrate heat treatment on small hand tools using oxyacetylene equipment.***

1. Demonstrate the safe use of oxyacetylene equipment.
2. Demonstrate oxyacetylene equipment to heat treat small hand tools.

K. Heat Treatment ..... **1 Hour**

Outcome: ***Perform heat treatment operations.***

1. Demonstrate an ability to perform heat treatment operations.

L. Oxyacetylene ..... **1 Hour**

Outcome: ***Perform heating, brazing and cutting operations using oxyacetylene equipment.***

1. Demonstrate an ability to perform operations using oxyacetylene equipment

M. Rigging ..... **1 Hour**

Outcome: ***Perform basic rigging operations.***

1. Demonstrate the use of hand signals.
2. Demonstrate and perform hoisting operations as they pertain to rigging and hardware.

SECOND PERIOD TECHNICAL TRAINING
TOOL AND DIE MAKER TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:..... THEORY ..... 48 HOURS

A. Milling Machines (150201a) ..... 4 Hours

Outcome: ***Describe milling machine types, parts and attachments.***

1. Describe the classification system for milling machine types.
2. Describe the use of the parts and controls on a knee and column, milling machine.
3. Describe the safe set-up and operation of milling machine attachments.

B. Milling Cutters (150201b) ..... 5 Hours

Outcome: ***Select the correct type of milling cutter and speed and feed for a machining application.***

1. Describe the types of materials used in the construction of milling cutters, and their applications and limitations.
2. Describe the arbour driven types of cutters used for operations on the horizontal milling machine.
3. Describe the types of cutters used for vertical milling machine operations.
4. Describe the care and handling of milling cutters.
5. Calculate the cutting speed, feed and depth of cut for various cutting tool and workpiece materials.

C. Tool and Work Holding Devices (150201c) ..... 2 Hours

Outcome: ***Select the proper tool and work holding device for a milling operation.***

1. Describe tool holding devices and their applications for the milling machine.
2. Describe work holding devices and their applications for the milling machine.

D. Milling Operations (150201d) ..... 9 Hours

Outcome: ***Describe the set-up and operation of a milling machine, using safe working procedures.***

1. Explain the difference between conventional and climb milling, and list the advantages of each.
2. Explain the difference between plain milling and face milling, and list the advantages of each.
3. Describe the set-up for cutting slots, keyways and keyseats.
4. Describe the set-up for using a slitting saw.
5. Describe the set-up for drilling and boring on a milling machine.
6. Describe the set-up for straddle, gang and from milling.
7. Describe the set-up for milling T-slots and dovetails.
8. Describe the set-up for hobbing a gear on a milling machine.

9. Describe safe procedures for operating a milling machine.

E. Dividing Head and Indexing (150201e) ..... 4 Hours

Outcome: ***Describe four methods of indexing using a dividing head.***

1. Describe the applications of a dividing head, and each individual part.
2. Describe four methods of indexing.
3. Describe the use of a wide-range dividing head.
4. Describe the use of a rotary table.

F. Advanced Threading (150201f) ..... 8 Hours

Outcome: ***Describe the types and uses of multiple start threads, translational threads, and taper threads***

1. Describe the purpose of multiple start threads.
2. Describe the types and uses of translational threads.
3. Describe taper threads and their uses.

G. Lathe Attachments and Accessories (150201g) ..... 4 Hours

Outcome: ***Perform lathe operations using lathe attachments and accessories.***

1. Describe the set-up and safe application of attachments used on the engine lathe.
2. Describe the set-up and safe application of accessories used on the engine lathe.

H. Advanced Cutting Tool Materials (150201h) ..... 4 Hours

Outcome: ***Describe the mechanics of chip formation, the characteristics of high-speed steel, cast alloy, and carbide cutting tool materials, their methods of manufacture and their applications.***

1. Describe the mechanics of chip formation.
2. Identify and describe cutting tool material compositions, applications, and manufacture.
3. Describe the machining operations that use carbide tooling.

I. Inserts and Tool Holders (150201i) ..... 4 Hours

Outcome: ***Choose and identify carbide inserts and tool holders.***

1. Interpret cutting tool geometry and its purpose.
2. Select an insert to provide the best operating conditions and economic performance for the job.
3. Interpret the ANSI and SI systems for the identification of carbide inserts and tool holders.

J. Using Carbide Inserts (150201j) ..... 2 Hours

Outcome: ***Select the correct cutting conditions for an insert and identify and correct any problems that might arise.***

1. State the required operating conditions for carbide tools.
2. Describe carbide tool failure and the troubleshooting methods to safely correct the problem.

K. Shapers and Slotters (150201k) ..... 2 Hours

Outcome: ***Describe various types of shapers, slotters, their parts, operations and applications.***

1. Identify the crank and hydraulic shapers.
2. Describe the difference between a shaper and a slotter.
3. List safety precautions regarding shapers and slotters.

SECTION TWO: ..... COMPUTER NUMERICAL CONTROL MACHINES ..... 12 HOURS

A. CNC Machines: Introduction and Application (150202a) ..... 2 Hours

Outcome: ***Identify and explain basic CNC concepts, types of application of CNC machines, advantages, disadvantages and safety issues.***

1. Define basic terms used in CNC programming and machining.
2. Identify and describe the types of and applications for CNC machines.
3. State and discuss the advantages and disadvantages of CNC machines.
4. Identify and discuss safety practices when using CNC machines.

B. CNC Turning Centers: Machine Types, Parts and Work holding Accessories (150202b) ..... 2 Hours

Outcome: ***Identify and explain basic CNC concepts and applications, parts and features of CNC turning centers.***

1. Types of CNC lathes and turning centers.
2. Identify and describe the parts, functions and features of CNC turning centers.
3. Identify the elements of a CNC drive system.
4. Identify and describe workholding devices and accessories used on CNC turning centers.

C. CNC Turning Centers: Program and Machine Coordinate Systems (150202c) ..... 2 Hours

Outcome: ***Identify, determine and explain the purpose of co-ordinate and reference points used for CNC lathe programs.***

1. Determine co-ordinate points of a workpiece for both radius and diameter programming using absolute and incremental values.
2. Identify and explain the purpose of the CNC lathe axis system.
3. Identify and state a purpose for reference points used on CNC turning centers.

D. CNC Turning Centers: Cutting Conditions and Operations (150202d) ..... 2 Hours

Outcome: ***Identify, select and apply speeds, feeds and depths of cut for turning operations. Identify the types and purposes of common turning operations.***

1. Determine and apply cutting conditions (speeds, feeds and depths of cuts) for basic lathe operations.
2. Identify and state the purpose of basic turning operations.

E. CNC Turning Centers: Programming Concepts and Codes (150202e)..... 2 Hours

Outcome: ***Identify and explain basic word address programming concepts and codes.***

1. Identify and explain elements of a word address program for a CNC turning center.
2. Identify and explain the purpose and application of preparatory (G) codes
3. Identify and explain the purpose and application of miscellaneous (M) codes.
4. Identify, explain and apply tool, feed rate, speed and related program commands.
5. Identify, explain and apply tool and workpiece co-ordinates, and related program codes.

F. CNC Turning Centers: Program Application (150202f) ..... 2 Hours

Outcome: ***Prepare and verify a word address program for CNC turning operations that include facing, cylindrical turning, center drilling and drilling operations.***

1. Identify and apply canned cycles for turning operations.
2. Write a CNC lathe program including the operations of facing, center drilling, drilling and cylindrical turning.
3. Explain methods of inputting, sorting and verifying CNC programs.

SECTION THREE: ..... METALLURGY ..... 16 HOURS

A. Base Metals and Alloys (150203a) ..... 10 Hours

Outcome: ***Select the type of metal or alloy for the required operation.***

1. Describe the physical and mechanical properties of metals.
2. Describe the applications and mechanical properties of alloying elements used in steel.
3. Describe the characteristics of seven types of ferrous metals or alloys for machining operations.
4. Describe the characteristics of nine types of non-ferrous metals or alloys for machining operations.

B. Metal Specifications and Testing (150203b) ..... 6 Hours

Outcome: ***Use metal specifications to select the correct metal for an application.***

1. Interpret charts and tables to select a metal for an application.
2. Describe six methods of destructive testing of metals
3. Describe four methods of non-destructive testing of metals.

SECTION FOUR: ..... TRADE MATHEMATICS..... 24 HOURS

The mathematics content in this course outline should maintain relevancy to technical training and be directly related to practical job applications.

A. Measurements, Conversions, Ratio and Proportion.....6 Hours

Outcome: ***Use measurement, conversion, ratio and proportion to solve problems.***

1. Describe and identify imperial and metric systems of measurement and their applicable units.
2. Demonstrate an ability to solve various problems with the use of proper formulae in both imperial and metric.
3. Be able to demonstrate an ability to convert imperial measurements to metric and vice versa using appropriate formula.
4. Demonstrate an ability to solve various problems with the use of proper formula in both imperial and metric for area, volumes, perimeter and circumference.
5. Demonstrate an ability to compute various problems applying ratio and proportion formula relating to gearing and pulleys.

B. Applied Mathematics.....14 Hours

Outcome: ***Demonstrate the ability to apply mathematics using various calculations, tables and charts.***

1. Demonstrate an ability to perform calculations on practical applications involving triangle theory and methods.
2. Demonstrate an ability to perform calculations on practical applications involving ratio and proportion formula.
3. Demonstrate an ability to read and interpret tables and charts.

C. Applied Geometry.....4 Hours

Outcome: ***Demonstrate the ability apply geometry in calculation and problem solving.***

1. Identify and describe common geometric forms and terminology.
2. Be able to calculate the area of a triangle in both imperial and metric using the base altitude method and the three side method.
3. Be able to make various calculations on circles in both imperial and metric using proper formula and equations.
4. Be able to calculate the area of an ellipse and a trapezoid in both imperial and metric using proper formulae and equations.
5. Be able to calculate volume and weight (mass) in both imperial and metric using proper formula and equations.
6. Demonstrate an ability to calculate area and volumes in both metric and imperial using similar-figure method.

SECTION FIVE: ..... PRINT READING ..... 24 HOURS

A. Interpret and Sketch Prints (150205a) ..... 8 Hours

Outcome: ***Interpret and sketch prints containing advanced technical information.***

1. Identify accumulation of tolerances.
2. Apply dimensions to tapers on sketching exercises.
3. Sketch and dimension technical element such as threads, boxes and countersinks.
4. Sketch and interpret a component in orthographic projection having a auxiliary view.
5. Sketch a pictorial drawing in isometric projection showing inclined surfaces, tapers and other technical elements.

B. Symbols and Abbreviations (150205b) ..... 8 Hours

Outcome: ***Interpret various advanced symbols and abbreviations that are commonly seen on prints.***

1. Apply machining allowance symbols to component drawings to meet industry standards.
2. Describe the application and definitions associated with surface finish texture symbols.
3. Describe the specification associated with surface finish texture symbols.
4. Describe the purpose of a welding symbol.
5. Interpret the elements of a welding symbol.
6. Interpret elementary weld symbols for fillet welds.
7. Interpret elementary weld symbols for groove welds.
8. Identify basic weld symbols for plug, spot, and seam welds.
9. Identify basic structural steel shapes.
10. Interpret blueprints containing welding, machining and or structural steel shapes.

C. Assembly and Sub-assembly Drawings (150205c) ..... 8 Hours

Outcome: ***Sketch and interpret sub-assembly and assembly drawings.***

1. Define the purpose of assembly drawings.
2. Sketch the layout and features typical of sub-assembly drawings.
3. Sketch the layout and features typical of assembly drawings.
4. Interpret part identification methods and bills of material on assembly drawings.
5. Interpret information found on assembly drawings and sub-assembly drawings.

SECTION SIX:.....MACHINERY'S HANDBOOK..... 8 HOURS

A. Machinery's Handbook (150206a).....8 Hours

Outcome: ***Use the Machinery's Handbook to locate and interpret various tables, charts, graphs, text and other relevant information applicable to machine shop operations.***

1. Describe the Machinery's Handbook and explain its advantages.
2. Explain how to find information in the Machinery's Handbook.
3. Explain how to interpret tables, charts and other information found in the Machinery's Handbook.
4. Describe the contents of the Machinery's Handbook as applicable to the second year curriculum.

SECTION SEVEN: .....SHOPWORK..... 112 HOURS

Shop work experience should relate items outlined in the theory section to shop operations by producing selected shop projects. This experience should complement the theory instruction by providing opportunities for efficient productive and safe operation and/or demonstration of.

A. Milling Machines .....54 Hours

Outcome: ***Set-up and operate various types of milling machines and their attachments.***

1. Demonstrate an ability to perform set-ups and operations on milling machines.
2. Demonstrate an ability to perform set-ups and operations on milling machine tooling.
3. Demonstrate an ability to use various tool holding devices for milling machines and their operations.
4. Perform speed and feed selections and settings for various milling operations.
5. Perform maintenance and lubrication requirements for milling machines.
6. Demonstrate an ability to use milling machine attachments in various milling operations.

B. Engine Lathes .....46 Hours

Outcome: ***Demonstrate an ability to cut screw threads with single point tools on the engine lathe.***

1. Demonstrate an ability to cut screw thread forms with single point tools on the engine lathe.

C. Lathe Attachments .....6 Hours

Outcome: ***Demonstrate the use of lathe attachments and their various tooling.***

1. Demonstrate an ability to use attachments and accessories for engine lathes.
2. Demonstrate an ability to select and use carbide and oxide tooling.

D. CNC Machining .....6 Hours

Outcome: ***Perform CNC machining as outlined in the theory section.***

1. Demonstration on a CNC lathe to reinforce related items outlined in the theory section.

THIRD PERIOD TECHNICAL TRAINING
TOOL AND DIE MAKER TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:..... ABRASIVE PRODUCTS..... 6 HOURS

A. Abrasive Products.....6 Hours

Outcome: ***Use abrasive materials and components for various operations.***

1. Identify safety rules and precautions, proper care and storage methods pertaining to grinding wheels.
2. Identify and describe common shapes, selection, identification of grinding wheels and their applications.
3. Describe and demonstrate truing, dressing, mounting and balancing procedures of grinding wheels.
4. Identify and describe various types of engineered abrasive products along with their construction characteristics (i.e. cloth or paper backed, grade and grain size) and their applications.
5. Describe precision (micro finishing) ultra finishing and non-precision processes, the equipment and machines used and their applications and purposes.

SECTION TWO:.....GRINDING MACHINES AND PROCESSES ..... 20 HOURS

A. Grinding Machines and Processes.....20 Hours

Outcome: ***Use grinding equipment and components for various operations and processes.***

1. Identify and describe various grinding machine types and their general applications.
2. Identify and describe various types, operations and procedures that are performed on cylindrical and universal cylindrical grinders and their applications.
3. Identify and describe the main parts of a horizontal spindle reciprocating table surface grinder and their purpose.
4. Identify common operations and procedures that may be performed on surface grinders.
5. Identify and describe work holding devices and methods utilised on various grinding processes.
6. Identify and describe the main parts, accessories and attachments of a universal cutter and tool grinder and their application.
7. Identify nomenclature of a milling cutter and describe their purpose.
8. Identify and describe common grinding fluid application methods and their purpose.
9. Identify, describe and calculate speed, feed and depth of cut for various grinding processes and the factors that can affect the surface finish in a grinding operation.

SECTION THREE: ..... GEARING ..... 11 HOURS

A. Gearing ..... 11 Hours

Outcome: ***Describe the basic theory of gear operation and application.***

1. Identify and describe various types of gears and their general applications.
2. Identify and describe terminology used in relation to gear and rack teeth parts.
3. Identify and describe two commonly used gear trains and their application.
4. Calculate speed and gear ratios for simple and compound gear trains.
5. Identify and describe common methods of manufacturing and finishing gears and/or racks.
6. Select the correct formulae and demonstrate an ability to calculate the elements necessary to cut a spur gear and rack.

SECTION FOUR: ..... BORING MILLS ..... 4 HOURS

A. Boring Mills ..... 4 Hours

Outcome: ***Describe the types of operations performed on boring mills.***

1. Identify safety rules and precautions when operation boring mills
2. Identify and describe various types of boring mills and their applications.
3. Identify tools and accessories and workholding devices used on boring mills and their applications.
4. Calculate speed and feed calculations for boring mill work.

SECTION FIVE: .....JIG BORING, GRINDING AND MACHINE BROACHING..... 3 HOURS

A. Jig Boring ..... 2 Hours

Outcome: ***Explain the operation of jig bores and grinders for accurate hole location.***

1. Identify and describe common tools and their applications for jig borers and grinders.
2. Describe the applications, expected accuracy, methods and procedures used for location on jig boring and grinding.
3. Identify and describe common tool holding devices and work holding devices and their applications for jig boring and grinding.

B. Machine Broaching ..... 1 Hour

Outcome: ***Describe broaching and use broaching machines.***

1. Describe the principle of broaching, common types of horizontal and vertical broaching machines and identify various applications where broaching is used.

SECTION SIX:..... JIGS AND FIXTURES..... 75 HOURS

A. Jigs .....45 Hours

Outcome: Design and apply jigs in tool and die making.

1. Identify and describe various types of jigs and their applications.
2. Describe design principles and other considerations relative to the production of jigs.
3. Describe locating and clamping devices and methods used on jigs.
4. Demonstrate ability to measure and analyze in-process work piece dimensions and surface verification.
5. Demonstrate ability to devise and detail a plan for the tool-building process.
6. Demonstrate the ability to devise and detail a plan for the tool-building process including the verification of jig features with engineering drawings.
7. Determine jig dimensions and values.
8. Produce shop floor hand sketches from piece-part specification for jig details and verify with the engineering drawing for dimensional accuracy.
9. Read and interpret engineering drawings to determine required materials.
10. Determine and develop a build plan.
11. Identify and describe machining methods and attachments to be used for fitting a jig.
12. Identify and select work holding devices.

B. Fixtures.....30 Hours

Outcome: Design and apply fixtures in tool and die making.

1. Identify and describe various types of fixtures and their applications.
2. Describe design principles and other considerations relative to the production of fixtures.
3. Describe locating and clamping devices and methods used on fixtures.
4. Demonstrate ability to measure and analyze in-process work piece dimensions and surface verification.
5. Demonstrate ability to devise and detail a plan for the tool-building process.
6. Demonstrate the ability to devise and detail a plan for the tool-building process including the verification of fixture component features with engineering drawings.
7. Determine fixture component dimensions and values.
8. Produce shop floor hand sketches from piece-part specification for fixture component details and verify with the engineering drawing for dimensional accuracy.
9. Read and interpret engineering drawings to determine required materials.
10. Determine and develop a build plan.
11. Identify and describe machining methods and attachments to be used for fitting fixture components.
12. Identify and select work holding devices.

SECTION SEVEN: .....SHOP ESTIMATING..... 4 HOURS

A. Introduction to Shop Estimating .....4 Hours

Outcome: ***Use shop estimating processes for estimating and planning.***

1. Demonstrate an ability to do a material take off from a print and prepare a proper listing and costing of materials.
2. Plan and list sequentially all aspects of a project that must be performed to complete the job according to a print.
3. Perform cost estimates for jobs including job planning sequences, material take offs and job planning operations.

SECTION EIGHT: .....WELDING..... 10 HOURS

A. TIG and Micro Welding.....10 Hours

Outcome: ***Use basic TIG and micro-welding.***

1. Introduction to TIG and Micro welding.

SECTION NINE:.....COMPUTER NUMERICAL CONTROL MACHINES ..... 55 HOURS

A. Machine Types, Parts and Functions (150402a).....4 Hours

Outcome: ***Explain the purpose of CNC machining centers, milling machines, their parts and functions.***

1. Identify the types of CNC machining centers and milling machines with appropriate applications.
2. Identify and describe the parts, functions and features of a CNC machining center.
3. Identify the elements of a CNC drive system and probes.
4. Identify and describe workholding devices and accessories used on CNC machining centers.
5. Identify and discuss safety practices when using CNC machines.

B. Manufacturing Systems (150402b) .....3 Hours

Outcome: ***Use manufacturing systems; flexible manufacturing system (FMS) and computer integrated manufacturing (CIM).***

1. Identify and explain the flexible manufacturing system (FMS).
2. Identify and explain the computer integrated manufacturing (CIM) system.

C. Machine and Workpiece Co-ordinate Systems (150402c).....5 Hours

Outcome: ***Use co-ordinate systems, machine axis, work piece coordinates and reference points in CNC machining centers and milling machines.***

1. Identify, determine and apply co-ordinate systems and dimensions for programming.
2. Identify and explain the purpose of the machine axis system.
3. Identify and state a purpose for reference points and work co-ordinate system.
4. Identify and determine co-ordinate points for simple workpieces.

D. Programming Concepts, Codes and Structure (150402d) ..... 8 Hours

Outcome: ***Use CNC concepts, programming codes and applications.***

1. Identify CNC program concepts and terminology.
2. Identify, explain and apply preparatory (G) codes.
3. Identify, explain and apply miscellaneous (M) and speed (S) codes.
4. Identify, explain and apply tool (T) and feedrate (F) codes.
5. Identify, explain and apply block-skip program functions.
6. Identify, explain and apply workpiece shift and tool length offset program codes.
7. Identify components of a CNC program for machining centers and milling machines.

E. Machining Conditions (150402e) ..... 4 Hours

Outcome: ***Use speeds, feed rates and depth of cuts for common machining operations performed on machining centers and milling machines.***

1. Determine, select and apply cutting speeds for machining operations performed on machining centers.
2. Select, determine and apply feedrates for machining operations performed on machining centers.
3. Select, determine and apply depth of cut for milling operations.
4. Identify and state the purpose of common operations performed on machining centers and milling machines.

F. Canned Cycles: Theory (150402f) ..... 3 Hours

Outcome: ***Use canned cycles for drilling, boring and tapping operations performed on CNC machining centers and milling machines.***

1. Identify and explain the program variables used in canned cycles.
2. Identify, explain and apply drilling canned cycles.
3. Identify, explain and apply the tapping canned cycle.
4. Identify, explain and apply boring canned cycles.

G. Canned Cycles: Program Applications (150402g) ..... 6 Hours

Outcome: ***Use canned cycle programs for drilling type operations for CNC machining centers and milling machines.***

1. Identify and calculate co-ordinate points for typical hole patterns.
2. Identify and calculate depth of holes for drilling operations.
3. Identify and apply canned cycles for drilling type operations including tapping and boring.
4. Identify and apply canned cycles with repeat (L) function for linear and grid hole patterns.
5. Identify and apply canned cycles using polar co-ordinates.

H. Linear and Circular Interpolation (150402h) ..... 4 Hours

Outcome: ***Use linear and circular interpolation for profile milling operations.***

1. Identify elements of and apply linear tool path motions (linear interpolation) for milling operations.
2. Identify elements of circular interpolation for milling operations.
3. Identify, explain, calculate and apply arc modifiers for circular interpolation.
4. Write a CNC program including linear and circular tool path motions for machining centers and milling machines.

I. Cutter Radius Compensation (150402i) ..... 4 Hours

Outcome: ***Use cutter radius compensation (CRC) for machining workpiece profiles on CNC machining centers and milling machines.***

1. Identify and calculate the co-ordinates for cutter center path programming.
2. Identify and explain the program codes, machine setting and guidelines for cutter radius compensation (CRC).
3. Identify and state the advantages of CRC.
4. Identify and apply CRC for profile milling operations.

J. Advanced Programming Concepts and Application (150402j) ..... 8 Hours

Outcome: ***Select CNC machining centers, milling machines, their parts and functions for programming applications.***

1. Identify, select and apply subprograms for appropriate machining applications.
2. Identify and state an application for macro programs.
3. Identify, select and apply mirror image for appropriate machining applications
4. Identify, select and apply co-ordinate rotation for appropriate machining applications.
5. Identify, select and apply helical milling for thread milling operations.
6. Identify, select and apply part zero shift programming techniques.

K. Set-Up and Operations (150402k) ..... 6 Hours

Outcome: ***Perform set-up and machining operations on CNC milling machines and machining centers.***

1. Identify and perform tool-loading operations into tool magazines.
2. Identify the sequence of operations for sequential (direct) tool change operation.
3. Identify the sequence of operations for a swing-arm tool change operation.
4. Identify and perform tool length and tool length offset measurements.
5. Identify and perform workpiece co-ordinate or workshift measurements.
6. Identify and state the purpose of common features found on the operator's panel of a machining center.

SECTION TEN: ..... TRADE MATHEMATICS ..... 24 HOURS

A. Applied Mathematics ..... 2 Hours

Outcome: ***Perform calculations using applied mathematics.***

1. Demonstrate an ability to create and interpret tables, charts and graphs.

B. Introduction to Trigonometry ..... 8 Hours

Outcome: ***Perform calculations using trigonometry.***

1. Identify and define terms related to right triangles and basic trigonometry.
2. Use tables of natural trigonometric functions to find the angles for given values.
3. Be able to properly perform functions to calculate angles for given values with the use of a calculator with trigonometric functions.
4. Be able to correctly solve problems for parts of different triangles.

C. Shop Applications of Trigonometry - Imperial and Metric ..... 12 Hours

Outcome: ***Perform calculations using shop application of trigonometry –Imperial and metric.***

1. Use trigonometry to solve common machine shop problems

D. CNC Math ..... 2 Hours

Outcome: ***Perform calculations for CNC math.***

1. Introduction to CNC math.

SECTION ELEVEN: ..... COMPUTER AIDED DESIGN (CAD) ..... 14 HOURS

A. CAD Interface ..... 2 Hours

Outcome: ***Describe CAD interface.***

1. Describe the graphics and text screen.
2. Describe how to communicate with CAD.

B. Getting Started with CAD ..... 2 Hours

Outcome: ***Use commands and system variables in CAD.***

1. Define and explain how to execute command and system variables available in CAD.
2. Describe and apply the command and system variables.

C. CAD Theory ..... 2 Hours

Outcome: ***Describe the theory of CAD drawings and special characters.***

1. Describe CAD's drawing theory and explain how it relates to scale, measurement and size.
2. Describe special CAD characters.

D. CAD Settings ..... 8 Hours

Outcome: ***Apply and use CAD settings.***

1. Describe, check and apply commands, modes and explain data input using both linear and angular units.
2. Define, describe and identify the object snap points for CAD's basic object types.
3. Describe and apply the Cartesian coordinate system, polar coordinate system, absolutes and incremental coordinates.
4. Demonstrate programming techniques to allow for importing CAD drawings into a Computer Aided Manufacturing (CAM) software format.

SECTION TWELVE: .....METROLOGY ..... 6 HOURS

A. Metrology ..... 6 Hours

Outcome: ***Use precision tools, measuring tools and equipment.***

1. Describe comparators', their applications accuracy and procedures.
2. Describe coordinate measuring system and procedures.
3. Describe coordinate locating system and procedures.

SECTION THIRTEEN: .....MACHINERY'S HANDBOOK..... 8 HOURS

Instruction in the use of this book is intended to provide the Tool and Die Maker apprentice with an opportunity to use the Machinery's handbook to solve various trade related problems by augmenting theory with the use of tables, formulae, examples and other information.

A. Machinery's Handbook ..... 8 Hours

Outcome: ***Use the Machinery's Handbook.***

1. Use the Machinery's handbook to locate, interpret and utilize tables, graphs charts and other information pertinent to the tool and die shop requirements.

FOURTH PERIOD TECHNICAL TRAINING
TOOL AND DIE MAKER TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... METROLOGY ..... 8 HOURS

A. Metrology ..... 8 Hours

Outcome: ***Use advanced precision tools, measuring tools and equipment.***

1. Describe and demonstrate set-up coordinate systems, work planes, probes and axis alignment.
2. Describe and demonstrate the setting up and printing reports in various forms.

SECTION TWO: ..... MILLING TECHNOLOGY ..... 10 HOURS

A. Milling Technology ..... 10 Hours

Outcome: ***Use advanced milling machines and their processes.***

1. Describe and demonstrate the advanced use of milling machines.
2. Describe and demonstrate safe work habits and procedures and maintenance.
3. Describe and demonstrate the selection of milling attachments, holding devices and accessories.

SECTION THREE: ..... GRINDING TECHNOLOGY ..... 15 HOURS

A. Grinding Technology ..... 15 Hours

Outcome: ***Use grinding machines and their processes.***

1. Describe and demonstrate the procedures used to plan the sequence for grinding operations.
2. Identify potential problems during grinding operations, their causes and remedies.
3. Describe and demonstrate the methods for calculating, grinding and checking clearance angles.
4. Identify and demonstrate the preventive maintenance procedures for tool and cutter grinders.

SECTION FOUR: ..... ELECTRICAL DISCHARGE MACHINING ..... 12 HOURS

A. Electrical Discharge Machining and Sinker Process ..... 12 Hours

Outcome: ***Use electrical discharge machines and sinker processes.***

1. Describe and demonstrate the use and operating principles of the EDM machines and sinker process.
2. Describe and demonstrate EDM wire machining techniques to produce die components.
3. Describe and demonstrate safe working habits when operating EDM machines.

SECTION FIVE: ..... CNC TECHNOLOGY ..... 28 HOURS

A. CNC Technology for Tool and Die Making ..... 28 Hours

Outcome: ***Use CNC technology as applied to tool and die making.***

1. Describe and demonstrate the creation of a tool and material library and compile set-up sheets.
2. Describe and demonstrate safe working procedures when setting up and operating CNC machines.
3. Describe and demonstrate the ability to write and document a program for a project to machine a workpiece that includes drilling, tapping and profiling using cutter compensation.
4. Describe and demonstrate importing, editing, selecting tools, roughing and finishing, and pocket routines.
5. Read and interpret job documentation to determine job requirements.
6. Describe and demonstrate the use of codes used in CNC.
7. Identify and describe design considerations for part locating and clamping fixtures.

SECTION SIX:.....STAMPING, FORGING MOULDING TECHNOLOGY ..... 25 HOURS

A. Stamping Technology ..... 10 Hours

Outcome: ***Use stamping die equipment and processes.***

1. Identify and describe stamping die components and terminology.
2. Describe and demonstrate the types of stamping die operations.
3. Describe and demonstrate the safety precautions pertaining to stamping operations.

B. Forging ..... 5 Hours

Outcome: ***Use forging in tool and die making.***

1. Describe and demonstrate the safety precautions pertaining to forging operations.
2. Describe and demonstrate various types of forging processes.
3. Identify forging die materials.

C. Mould Making ..... 10 Hours

Outcome: ***Use mould making in tool and die making.***

1. Describe and demonstrate mould applications and procedures.
2. Describe and demonstrate die casting applications and procedures.
3. Describe and demonstrate extrusion dies applications and procedures.
4. Identify mould design considerations.

SECTION SEVEN: ..... MECHANICAL ASSEMBLY TECHNOLOGY ..... 10 HOURS

A. Mechanical Assembly Technology for Tool and Die Making ..... 10 Hours

Outcome: ***Use mechanical assembly for tool and die making.***

1. Describe and demonstrate safe operations during mechanical assembly procedures.
2. Describe equipment and attachments to be used for the assembly of components.
3. Describe and demonstrate the working operating principles and design parameters of rack and pinion combinations.
4. Describe and demonstrate the operating principles and design parameters of cam and follower combinations.

SECTION EIGHT: .....DIE AND MOULD BUILDING ..... 100 HOURS

A. Planning Process ..... 25 Hours

Outcome: ***Use the planning of die and mould building processes.***

1. Identify and describe the purpose of blank development.
2. Read and interpret engineering drawings for die assembly.
3. Verify die component features with engineering drawings.
4. Read and interpret engineering drawings to identify features of die sets.
5. Perform die related calculations using mathematical symbols, terminology, units and formulaes.
6. Produce hand sketches from piece-part specifications to illustrate die component details and verification with the .....engineering drawing for dimensional accuracy.
7. Read and interpret engineering drawings to determine required materials.
8. Determine and develop a build plan.
9. Identify and describe layout of die components.
10. Knowledge of engineered products.
11. Describe spotting, fitting die clearances, and confirming clearances for a die and moulds.

B. Machinery Process ..... 25 Hours

Outcome: ***Use die and mould building machinery and processes.***

1. Describe and demonstrate machining methods and attachment procedures to be used for fitting die components.
2. Describe and select work holding devices.
3. Describe and demonstrate machining processes to produce die components.
4. Identify, describe and select abrasive hand stones.
5. Identify, describe and select polishing abrasive compounds.
6. Identify, describe and select hand finishing of punch/die/component surfaces.
7. Identify, describe and select power equipment for the finishing of punch/die/component.
8. Demonstrate the ability to produce a die or a die component.

C. Assembly and Processes ..... 25 Hours

Outcome: ***Use die and mould building assembly and processes.***

1. Verify the sequence of sub and final assembly.
2. Hold and align mating die components.
3. Describe and demonstrate layout, fit and fasten die components and sub-assemblies.
4. Describe and demonstrate layout, fit and fasten die sub-assemblies for final assembly.

D. Production and Processes ..... 25 Hours

Outcome: ***Use die and mould building production and processes.***

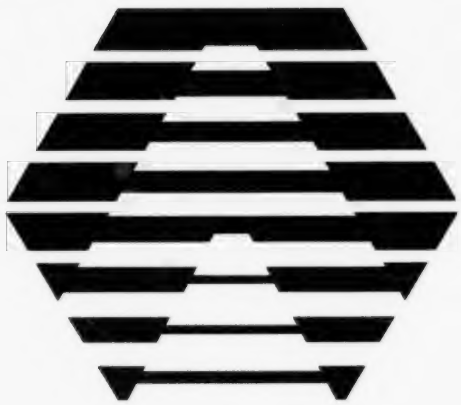
1. Describe demonstrate punch press safety systems and safety controls.
2. Determine, identify and select die try out-press.
3. Describe and demonstrate procedures for installing die in press.
4. Describe and demonstrate operating principles of presses.
5. Describe and demonstrate methods and procedures for verifying the piece-part.
6. Describe the causes of die or piece-part malfunction or failures.

SECTION NINE: ..... APPLIED TRADE CALCULATIONS ..... 32 HOURS

A. Advanced Math and Unknown Values ..... 32 Hours

Outcome: ***Use mathematical principles to shop related problems.***

1. Demonstrate and calculate perimeter, area and volumes.
2. Apply and perform calculations of bending allowances and draw die problems.
3. Apply and perform calculations as applied to the Cartesian coordinate system.
4. Apply and perform calculations related to applied right and oblique triangle trigonometry and 3D trigonometry.
5. Apply and perform calculations to determine the die/press/component dimensions and values.



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